Completed Project (2011 - 2014)

Autonomous Mission Operations Project

Advanced Exploration Systems Program | Human Exploration And Operations Mission Directorate (HEOMD)

ABSTRACT

The AES Autonomous Mission Operations project will develop understanding of the impacts of increasing communication time delays on mission operations and develop automation technologies to mitigate the impacts. The technologies are expected to reduce operations costs as well. This will be tested on ISS in FY14.

The results of this project are being incorporated and built upon in the Autonomous Systems and Operations project.

ANTICIPATED BENEFITS

To NASA funded missions:

This technology should increase mission success while decreasing probability of loss of life. It will also reduce cost of operations.

To NASA unfunded & planned missions:

This technology should increase mission success while decreasing probability of loss of life. It will also reduce cost of operations.

To the nation:

This technology should increase mission success for exploration missions beyond low Earth orbit while decreasing probability of loss of life. It will also reduce cost of operations.

DETAILED DESCRIPTION

Future human spaceflight missions will occur with crews and spacecraft at large distances, with long communication delays to the Earth. The one-way light-time delay to the Moon is 1.3 seconds, which is sufficient to make some scenarios (e.g. landing) difficult or impossible to conduct from Earth. One-way communication delays to human exploration destinations such as Near Earth Asteroids (NEA) at close approach range from

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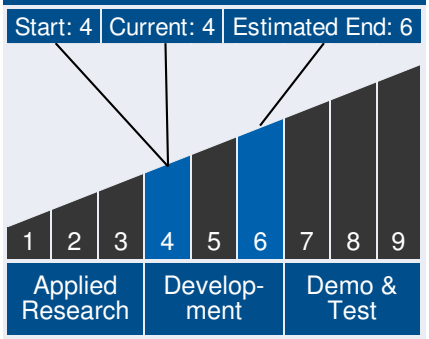
Technology Maturity



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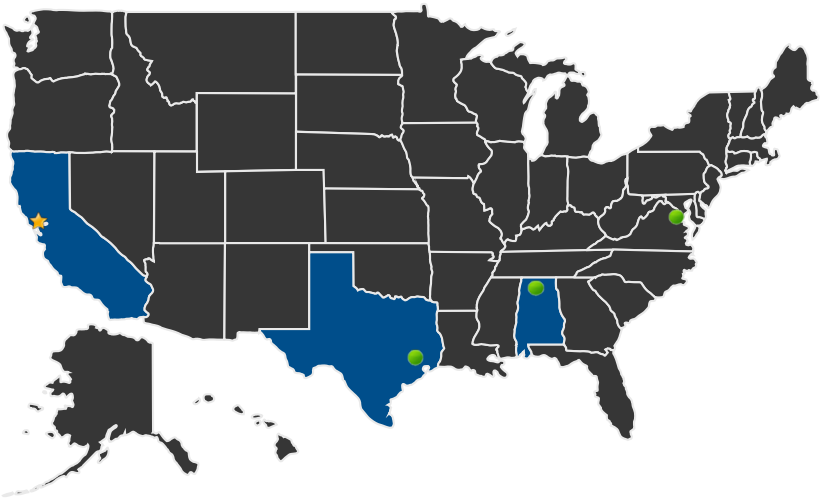
seconds to minutes. The one-way light-time delay to Mars ranges from 3 minutes (at conjunction) to 22 minutes (at opposition). As the communication delays increase, the crews in the spacecraft must execute, and manage, much of the mission themselves. Throughout the course of a mission, as distances increase, NASA must continue to migrate operations functionality from the Mission Control Center flight control room to the vehicle for use by the crew. The role of the ground control teams and systems will evolve away from real-time support to more long-range planning, diagnosis, analysis and prognostics support role, while the vehicle systems and crew must take on the role of onboard daily schedule execution, planning, and systems management. Both ground and vehicle systems will require automation to maximize crew functionality, minimize unnecessary overhead, and reduce operating costs. This project is to understand the impacts of increasing communications time delays on operations and to develop technologies to mitigate the impacts.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Ames Research Center

Realized Benefits

2 NASA Technology Uses

Management Team

Program Director:
- Jason Crusan

Program Executive:
- Richard Mcginnis

Project Manager:
- Jeremy Frank

Principal Investigator:
- Jeremy Frank

Technology Areas

Primary Technology Area:
Human Exploration Destination Systems (TA 7)
- Mission Operations and Safety (TA 7.5)
  - Integrated Flight Operations Systems (TA 7.5.3)
    - Autonomous Ground Operations (TA 7.5.3.2)

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Supporting Centers:

- Johnson Space Center
- Marshall Space Flight Center
- NASA Headquarters

PROJECT LIBRARY

NASA Technology Use

- Autonomous Mission Operations EXPRESS Autonomous Operations Project (AMO-EXPRESS)
  - (http://www.nasa.gov/mission_pages/station/research/exp
- Autonomous Mission Operations TOCA Autonomous Operations Project (AMO-TOCA) Experiment
  - (http://www.nasa.gov/mission_pages/station/research/exp

Technology Areas *(cont.)*

Secondary Technology Area:
Human Exploration Destination Systems (TA 7)
└ Mission Operations and Safety (TA 7.5)
  └ Integrated Flight Operations Systems (TA 7.5.3)
    └ Autonomous Crew Operations (TA 7.5.3.1)

Robotics and Autonomous Systems (TA 4)
└ System-Level Autonomy (TA 4.5)

Human Health, Life Support, and Habitation Systems (TA 6)

Modeling, Simulation, Information Technology and Processing (TA 11)
└ Information Processing (TA 11.4)
  └ Human-System Integration (TA 11.4.7)
    └ Crew Autonomy Mission Operation System (TA 11.4.7.2)

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Technology Areas *(cont.)*

Ground and Launch Systems (TA 13)
- Operational Life-Cycle (TA 13.1)
  - Autonomous Command and Control for Integrated Vehicle and Ground Systems (TA 13.1.3)
    - Automated Fault Detection and Isolation Systems (TA 13.1.3.5)

DETAILS FOR TECHNOLOGY 1

Technology Title

Autonomous Mission Operations

Technology Description

This technology is categorized as software memory for manned spaceflight

Future human spaceflight missions will occur with crews and spacecraft at large distances, with long communication delays to the Earth. The one-way light-time delay to the Moon is 1.3 seconds, which is sufficient to make some scenarios (e.g. landing) difficult or impossible to conduct from Earth. One-way communication delays to human exploration destinations such as Near Earth Asteroids (NEA) at close approach range from seconds to minutes. The one-way light-time delay to Mars ranges from 3 minutes (at conjunction) to 22 minutes (at opposition). As the communication delays increase, the crews in the spacecraft must execute, and manage, much of the mission themselves. Throughout the course of a mission, as distances increase, NASA must continue to migrate operations functionality from the Mission Control Center flight control room to the vehicle for use by the crew. The role of the ground control teams and systems will evolve away from real-time support to more long-range planning, diagnosis, analysis and prognostics support role. While the vehicle systems and crew must take on the role of onboard daily schedule execution, planning, and systems management. Both ground and vehicle systems will require automation to maximize crew functionality, minimize unnecessary overhead, and reduce operating costs. This project is to understand the impacts of increasing communications time delays on operations and to develop technologies to mitigate the impacts.

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Capabilities Provided

The technologies developed will enable effective crew and system operation regardless of disruptions or time delays in communications between the exploration crew and the Earth-based operations center.

Potential Applications

Initially, the intent is for human exploration missions beyond low Earth orbit. The technology is not specific to this and could be used anywhere autonomous systems are desired. This may be on the spacecraft or in control centers.